BIOLOGICAL EVALUATION OF GYPSY MOTH

At

CATOCTIN MOUNTAIN

2007

Prepared by

Rodney L. Whiteman
Forester

USDA Forest Service
Forest Health Protection
Morgantown, WV 26505

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ABSTRACT

In August and September, 2007, USDI Park Service and USDA Forest Service personnel conducted gypsy moth egg mass surveys at Catoctin Mountain Park (CMP). The purposes of these surveys were to determine gypsy moth population densities, evaluate the efficacy of this year's treatments, assess the potential for defoliation and the need for treatment in 2008. Current populations are sufficient to cause light and heavy defoliation on 3370 acres. Treatment is recommended to prevent defoliation and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all the new (2007) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. During the survey conducted by Forest Service personnel, egg mass lengths were measured at the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity.

RESULTS

The location of the survey plots established by the National Park Service are shown in Figure 1 while the location of the survey plots established by the US Forest Service are shown in Figure 2. The results of the National Park Service survey are presented in Table 1 while the results of the US Forest Service survey are presented in Table 2. The summarized results of these surveys are presented in Table 3. In brief, egg mass densities ranged from 0-23,800 and averaged 2101 egg masses per acre. Overall egg mass lengths tended to be large to extra-large in size, ranging from 18-60 mm and averaging 35 mm. Egg mass densities in the 2007 treatment areas ranged from 0-17,280 and averaged 2395 egg masses per acre while egg mass lengths in these two areas ranged from 20-50 mm and averaged 34 mm.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (30-50 percent); and heavy (51-100 percent). Defoliation less than 30 percent generally has little impact on trees and can not be detected through aerial surveys.

The survey results indicate that light defoliation is likely on 1141 acres and heavy defoliation on 2229 at CMP in 2008 (Figure 3).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and prediction defoliation. Using Liebhold's model, Figure 4, shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 2711 egg masses per acre (average egg mass density in block 1) x 33 mm (average egg mass length in block 1) translates to a projected defoliation level of about 71 percent (heavy defoliation). Because egg mass densities and the host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately heavy throughout this area of CMP. Heavy defoliation is also predicted for block 2 while light defoliation is projected for blocks 3-5.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at CMP. The average egg mass length is 35 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at CMP in 2007. Although it is still possible that either the gypsy moth fungus or the NPV could cause the general collapse of the gypsy moth population next year, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2008.

The results from the 2007 gypsy moth suppression project were mixed. Foliage protection was provided on approximately 99.4% of the treatment area. Only 7.4 acres of defoliation were detected within the treatment areas during the aerial survey conducted on June 11 (Figure 5). Widespread heavy defoliation also occurred on Piney Mountain to the north and Cunningham Falls State Park to the south. Egg mass densities in the treatment areas have increased 51.9 percent from their pre-treatment level (2006) of 1577 egg masses per acre to their current level of 2395 egg masses per acre. The average egg mass length in the treatment areas has remained 34 mm. All of the treatment areas will need to be re-treated in 2008.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 50 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to

deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light defoliation (<50 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. CMP experienced a prolonged and severe drought during the 2007 growing season.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak saw timber and 14 percent of the total oak pole timber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at CMP and the factors mentioned above, large areas of extensive tree mortality are expected if defoliation occurs. Mortality will be more severe if adequate rainfall is not received during the 2008 growing season.

Management Options

In 2008, two management options have been evaluated for managing gypsy moth populations at CMP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent branch dieback and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations, viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations

following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations information at hand, it is unlikely that a collapse will occur in 2008 since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al., (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely wide spread defoliation will occur at CMP in 2008.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk)*. This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al., (1996) in West Virginia. Miller's study involved a large scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1 year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½ -1 gallon per acre. With

proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 4×10^{11} occlusion bodies (OB's) per acre applied in a single application or 2×10^{11} OB's per acre applied in a double application. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2008 should this insecticide be preferred for use at CMP.

Alternatives

With the previously described options in mind, the following alternatives are offered:

Alternative 1. - No action.

Alternative 2. - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3. - Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4. - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre.

Alternative 5. - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations at CMP are healthy, building and sufficient to cause 1141 acres of light defoliation and 2229 acres of heavy defoliation in 2008. To protect tree foliage and prevent subsequent tree mortality, our recommendation is alternative 3 (a double application of *Btk*) in blocks 1 and 2 and alternative 2 (a single application of *Btk*) in blocks 3, 4 and 5.

This recommendation is based on the following considerations:

1) Based on the health and high gypsy moth population levels in blocks 1 and 2, a single application of *Btk* is not likely provide either foliage protection or a significant egg mass reduction.

2) The current population densities in blocks 3, 4 and 5 do not warrant a double application of *Btk*.

3) It is likely that a single application of *Btk* in blocks 3, 4 and 5 and a double application of *Btk* in blocks 1 and 2 will provide both foliage protection and significant population reduction.

4) Gypchek is less likely to provide adequate foliage protection or a significant population reduction than *Btk* .

5) There are no known threatened or endangered lepidopteron in the treatment areas.

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Table 1. – Results of the gypsy moth egg mass survey conducted by National Park Service personnel at CMP, August and September, 2007.

Plot #	#em/acre
1	0
2	0
3	0
4[z]	680
5	0
6	40
7[z]	160
8[z]	200
9	40
10	80
11	0
12	0
13[z]	1000
14[z]	1200
15[z]	1920
16[z]	280
17[z]	600
18[z]	480
19	0
20*[z]	400
21[z]	2000
22[z]	480
23[z]	1800
24[z]	1080
25[z]	600
26[z]	2000
27[z]	2000
28[z]	2000
29[z]	1480
30[z]	1520
31[z]	1840
32[z]	1200
33[z]	720
34[z]	5840

Plot #	em/acre
35[z]	1840
36[z]	600
37[z]	600
38[z]	840
39[z]	8000
40[z]	320
41[z]	1800
42*[z]	760
43*[z]	1240
44*[z]	80
45*[z]	160
46*[z]	80
47[z]	3000
48[z]	160
49[z]	480
50*[z]	5560
51*[z]	0
52*[z]	0
53*[z]	80
54*[z]	1200
55*[z]	80
56*[z]	120
57*[z]	280
58*[z]	2640
59*[z]	5160
60*[z]	2720
61*[z]	520
62*[z]	2080
63[z]	2400
64*[z]	0
65*[z]	0
66[z]	320
67[z]	4000
68*[z]	1760

* = located in 2007 treatment area
[z] = located in proposed 2008 treatment area

Table 2. – Results of the gypsy moth egg mass survey conducted by USDA Forest Service personnel at CMP, September 26 and 27, 2007.

Plot #	#em/acre	Average em size (mm)	Plot #	# em/acre	Average em size (mm)
1*[z]	320	—	36*[z]	1200	27
2*[z]	120	30	37*[z]	2120	40
3*[z]	680	31	38*[z]	840	44
4*[z]	240	42	39*[z]	1560	31
5*[z]	160	32	40*[z]	17,280	29
6*[z]	40	—	41*[z]	240	47
7*[z]	6560	33	42[z]	0	—
8*[z]	1240	28	43*[z]	1680	48
9*[z]	1520	32	44*[z]	0	—
10*[z]	5680	38	45*[z]	3920	36
11*[z]	160	48	46*[z]	2880	35
12*[z]	7080	31	47[z]	23,800	34
13*[z]	3960	32	48[z]	2240	39
14*[z]	9240	34	49*[z]	4040	26
15*[z]	3920	29	50*[z]	840	—
16*[z]	7080	26	51*[z]	760	24
17*[z]	4720	33	52*[z]	5680	27
18*[z]	2040	33	53*[z]	680	31
19*[z]	2520	25	54*[z]	8400	30
20*[z]	2280	36	55*[z]	2760	37
21*[z]	2360	29	56*[z]	4440	37
22*[z]	5720	29	57*[z]	120	—
23*[z]	600	28	58*[z]	4440	33
24*[z]	6880	26	59	0	—
25*[z]	1920	27	60	0	—
26*[z]	2320	29	61[z]	280	35
27*[z]	2760	35	62[z]	1520	39
28*[z]	1520	35	63[z]	360	30
29*[z]	2800	31	64[z]	920	35
30*[z]	2640	31	65	200	—
31*[z]	1680	33	66	840	33
32*[z]	0	—	67	0	—
33*[z]	0	—	68	0	—
34*[z]	3640	32	69	0	—
35*[z]	3920	37	70	0	—

Table 2 (continued)

Plot #	# em/acre	Average em size (mm)	Plot #	# em/acre	Average em size (mm)
71[z]	1080	33	107[z]	1680	38
72	40	—	108[z]	720	40
73	200	42	109[z]	2000	45
74	0	—	110[z]	6440	42
75[z]	3680	34	111[z]	1200	35
76	80	34	112[z]	5560	39
77[z]	1720	—	113[z]	20,760	44
78[z]	1160	40	114[z]	23080	48
79[z]	240	—	115[z]	1400	35
80[z]	360	—	116[z]	6960	37
81[z]	840	35	117[z]	1200	35
82[z]	3640	41	118[z]	15,440	38
83[z]	880	34	119[z]	880	39
84[z]	2320	39	120[z]	480	28
85[z]	160	—	121[z]	120	—
86[z]	640	33	122[z]	0	—
87[z]	800	43	123[z]	4160	23
88[z]	840	49			
89	600	33			
90[z]	2520	39			
91[z]	840	—			
92[z]	40	—			
93[z]	40	—			
94[z]	1480	20			
95[z]	0	—			
96[z]	640	42			
97[z]	0	—			
98[z]	160	40			
99[z]	160	—			
100[z]	1080	25			
101[z]	680	30			
102[z]	1200	38			
103[z]	4240	37			
104[z]	8040	37			
105[z]	280	42			
106[z]	1040	46			

Table 3 – Summarized results of the gypsy moth egg mass surveys conducted at CMP by the National Park Service and USDA Forest Service from August – September, 2007.

overall em/ac range = 0-23,800
overall em/ac average = 2101

overall em size range (mm) = 18-60
overall em size average (mm) = 35

em/ac range in 2007 treatment areas = 0-17,280
em/ac average in 2007 treatment areas = 2395

em size range (mm) in 2007 treatment areas = 20-50
em size average (mm) in 2007 treatment areas = 34

em/ac average in proposed 2008 treatment block 1 = 2711
em size average (mm) in proposed 2008 treatment block 1 = 33

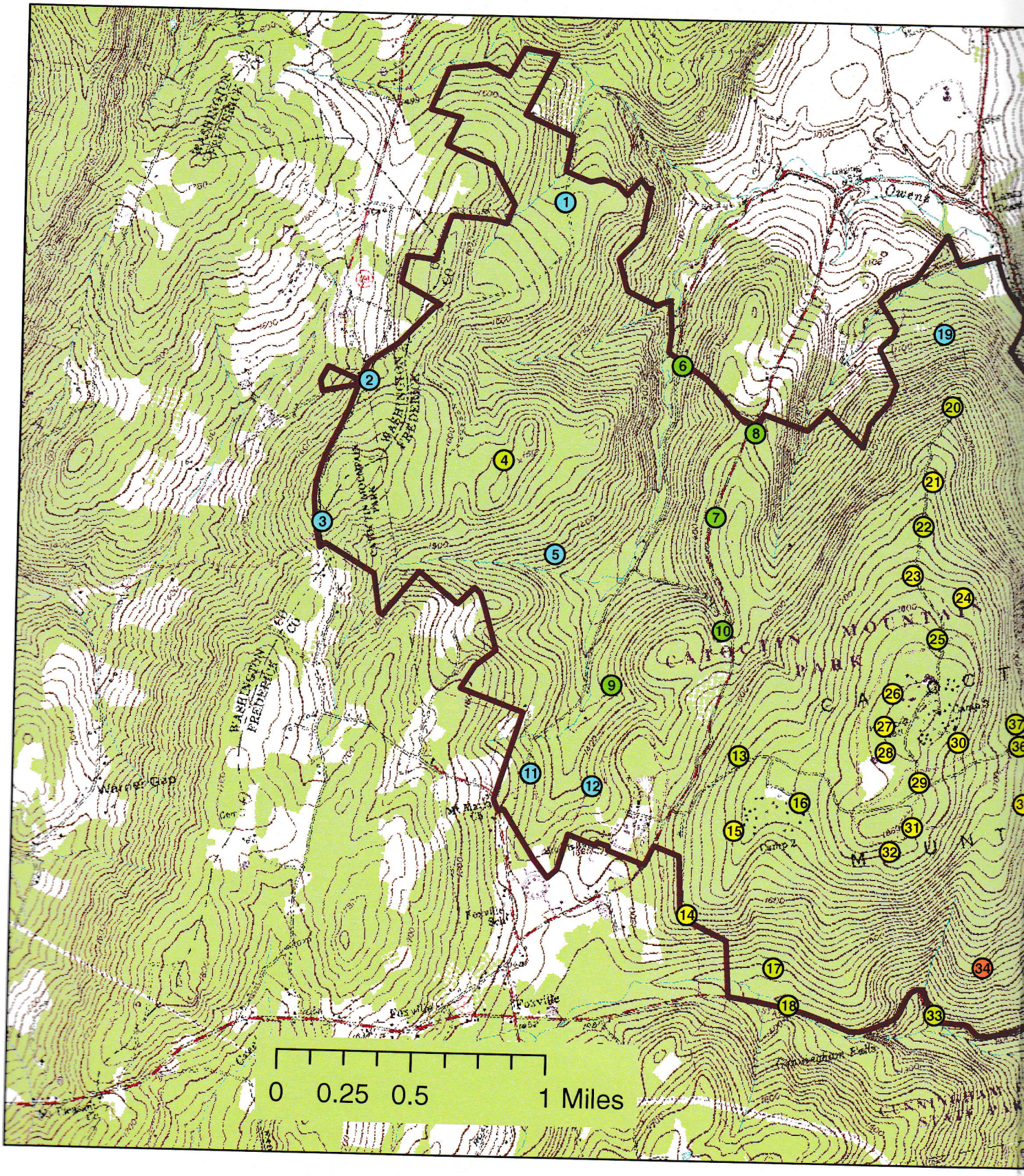
em/ac average in proposed 2008 treatment block 2 = 3671
em size average (mm) in proposed 2008 treatment block 2 = 38

em/ac average in proposed 2008 treatment block 3 = 1073
em size average (mm) in proposed 2008 treatment block 3 = 34

em/ac average in proposed 2008 treatment block 4 = 696
em size average (mm) in proposed 2008 treatment block 4 = 40

em/ac average in proposed 2008 treatment block 5 = 807
em size average (mm) in proposed 2008 treatment block 5 = 34

Figure 1. -- NPS gypsy moth egg mass survey plot locations at CMP, August and Septembe



er, 2007.

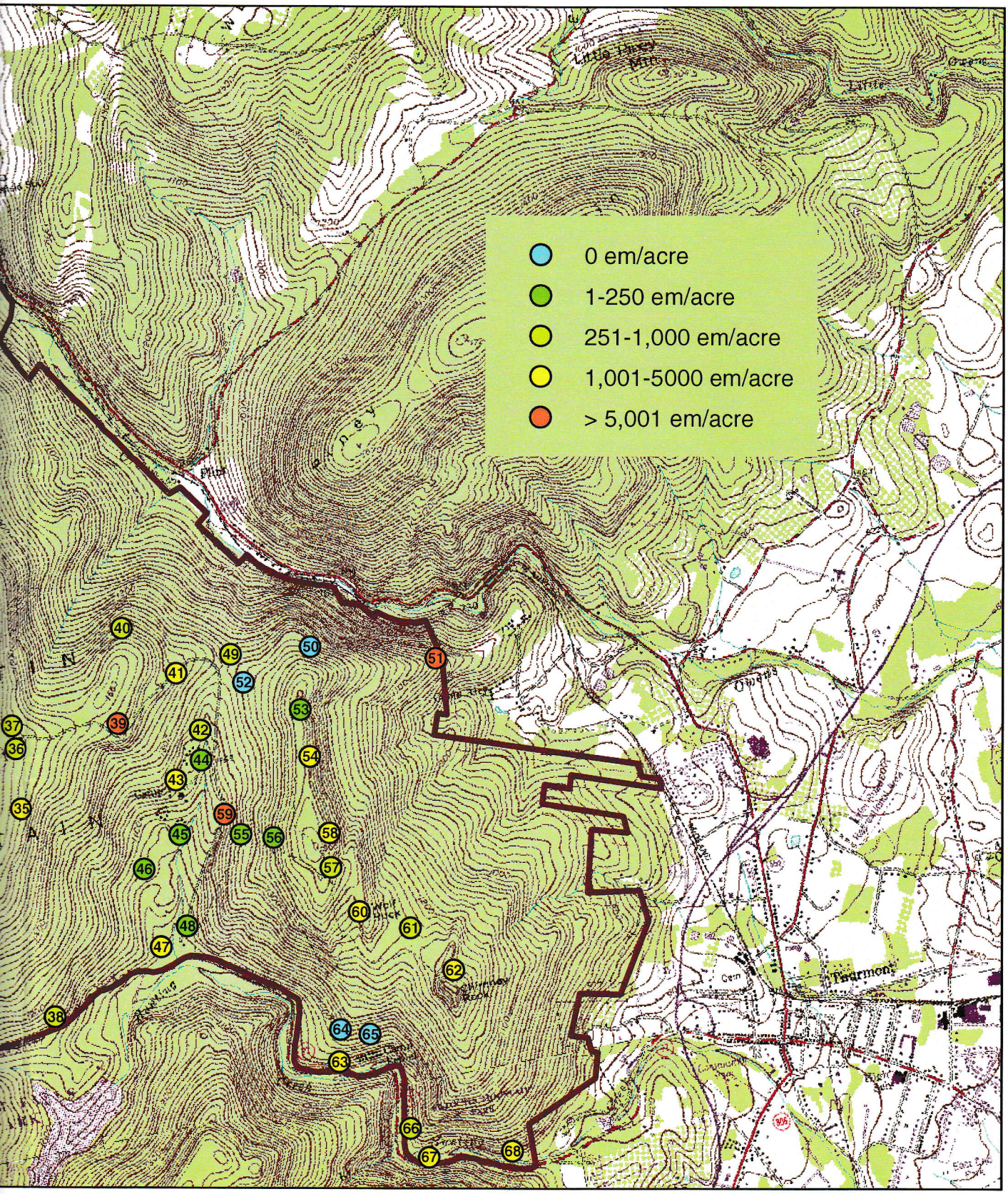

0 em/acre
1-250 em/acre
251-1,000 em/acre
1,001-5000 em/acre
> 5,001 em/acre
Little Hazy Mtn
Pine
Tadmore
Cem
Wolf Rock
Owens
Little
Creek
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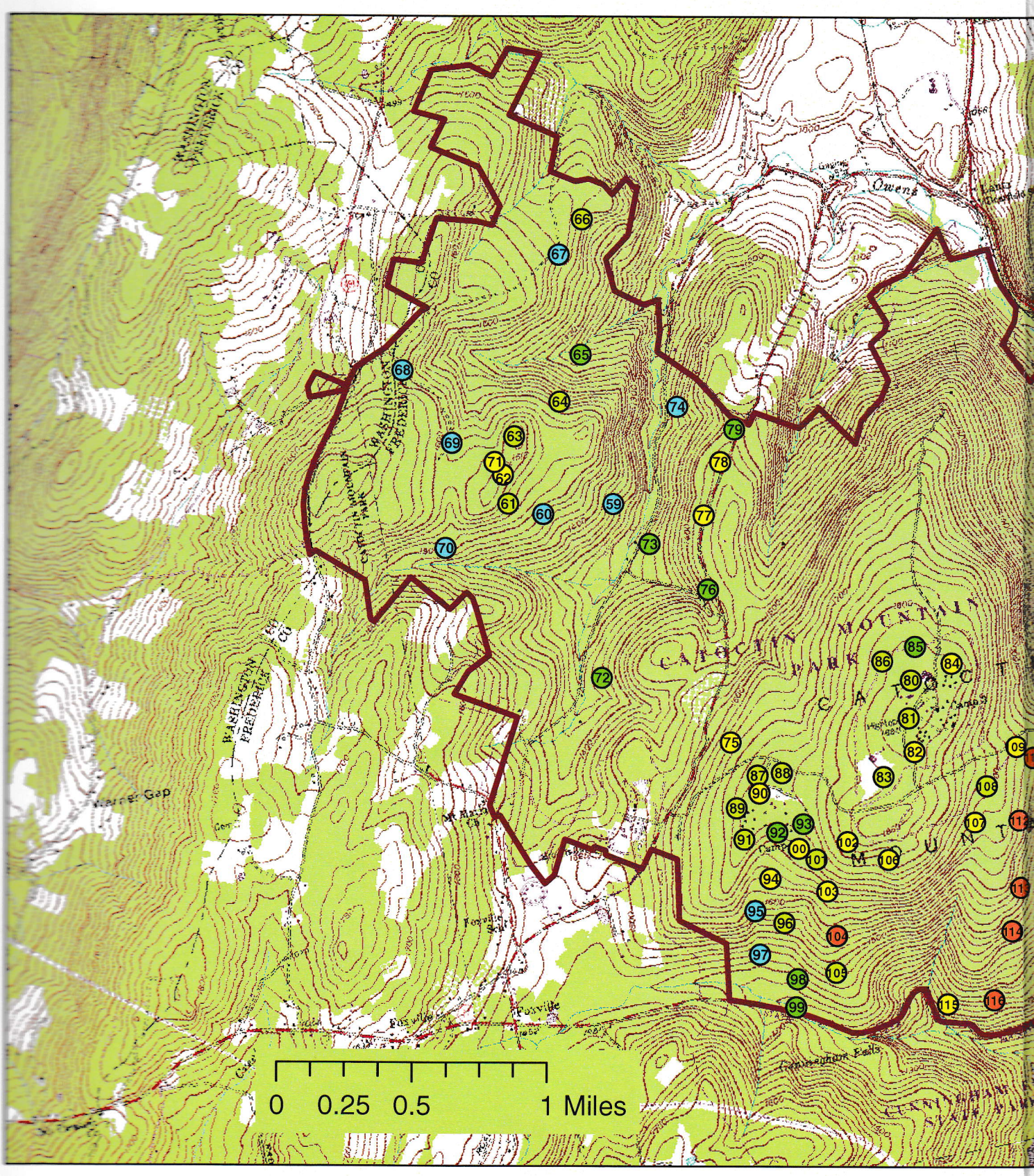
Figure 2. -- USFS gypsy moth egg mass survey plot locations at CMP, September 26 and 2



d 27, 2007.

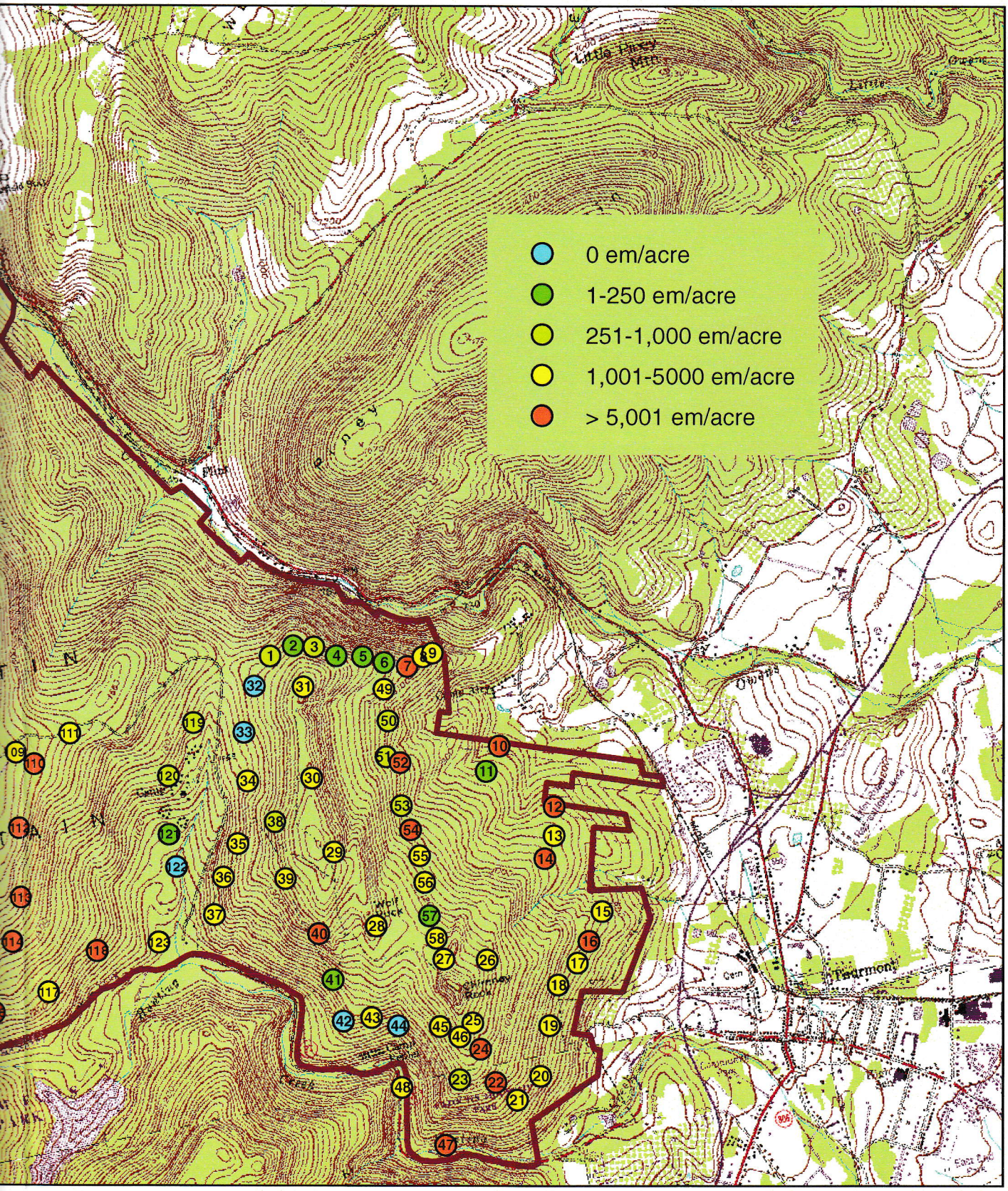
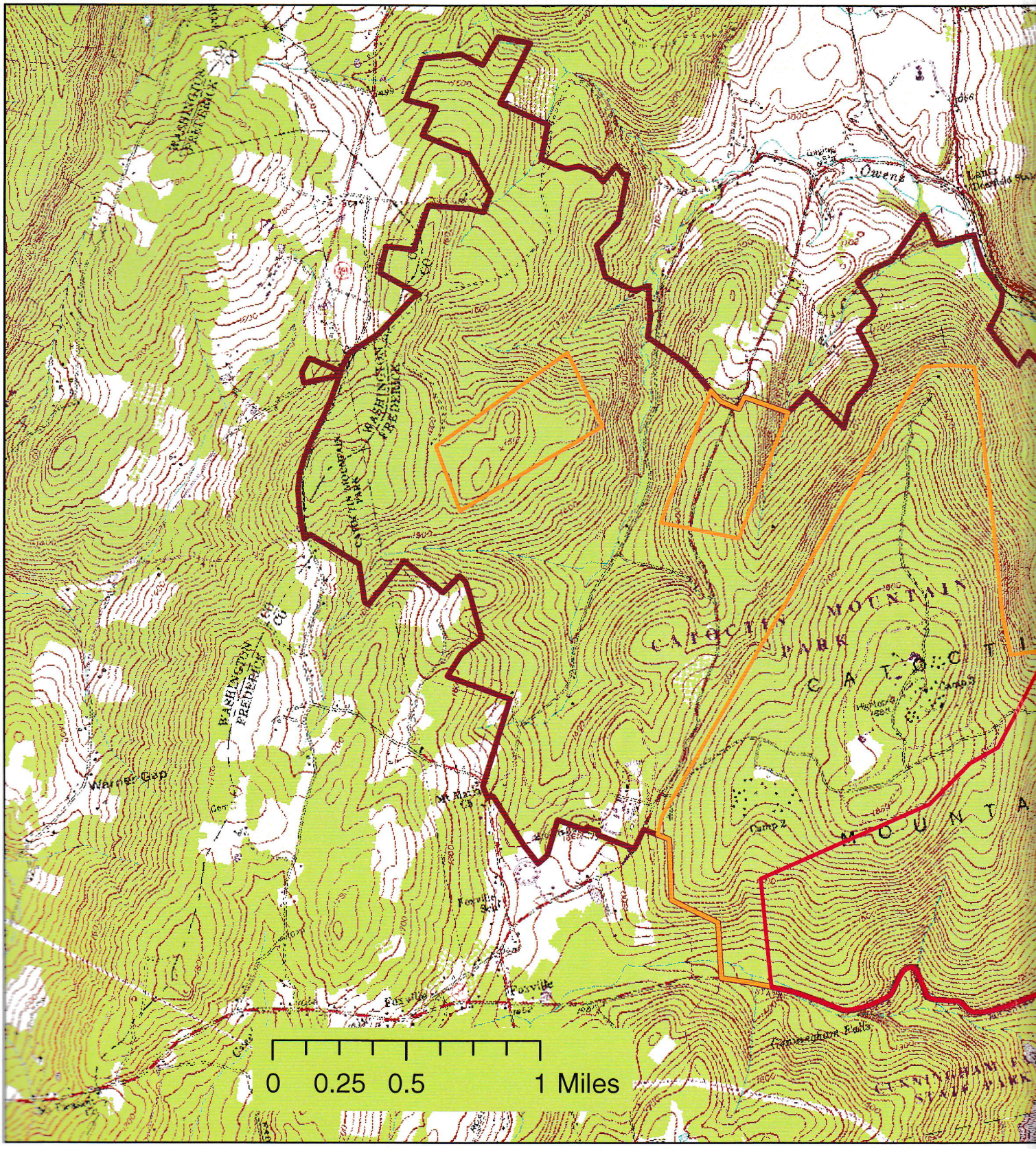

0 em/acre
1-250 em/acre
251-1,000 em/acre
1,001-5000 em/acre
> 5,001 em/acre
Little Flint Mtn.
Flint
Wolf Quick
Chimney Rock
Tearmont

Figure 3. -- Areas where defoliation in likely in 2008/ proposed spray blocks at CMP.



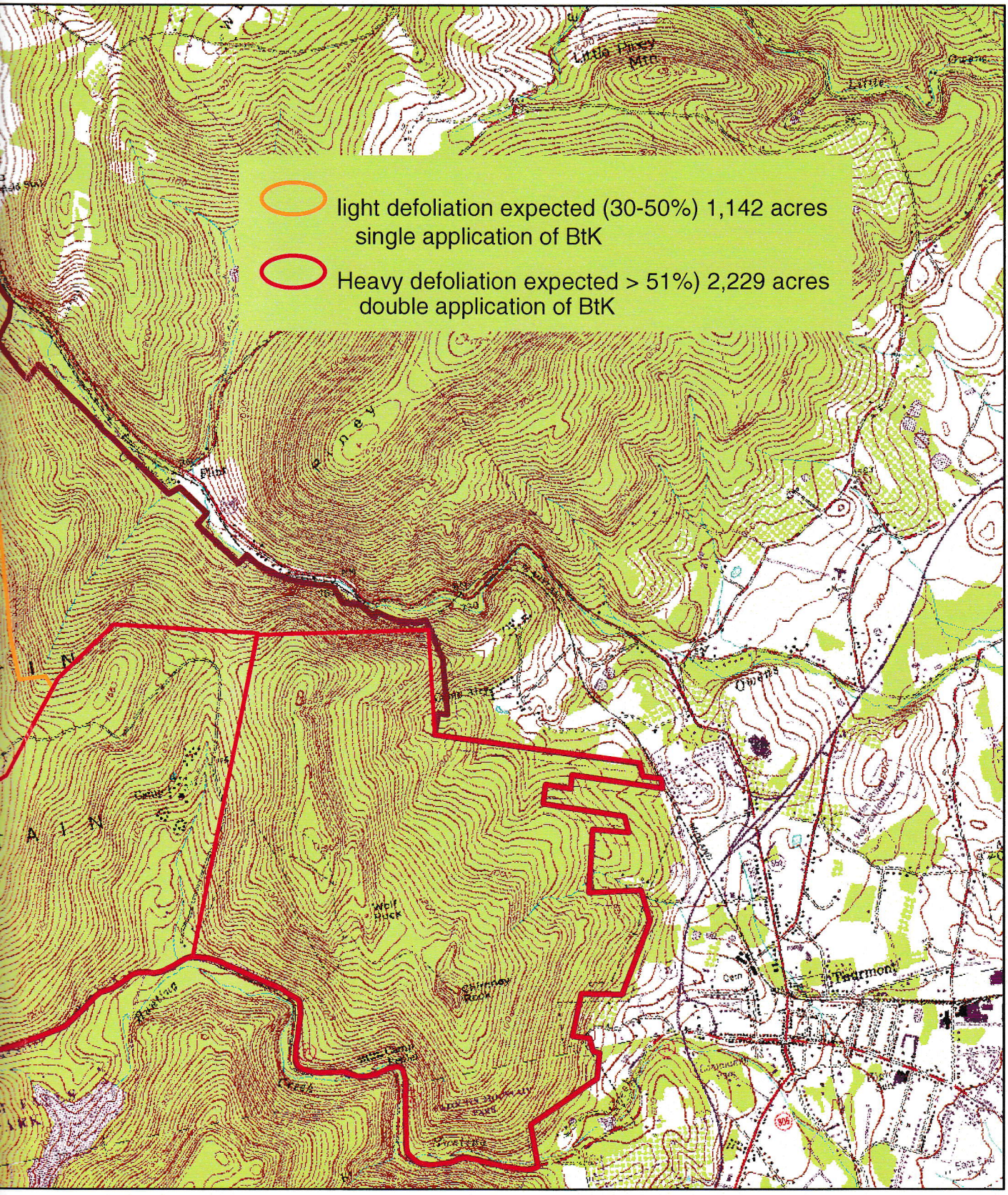
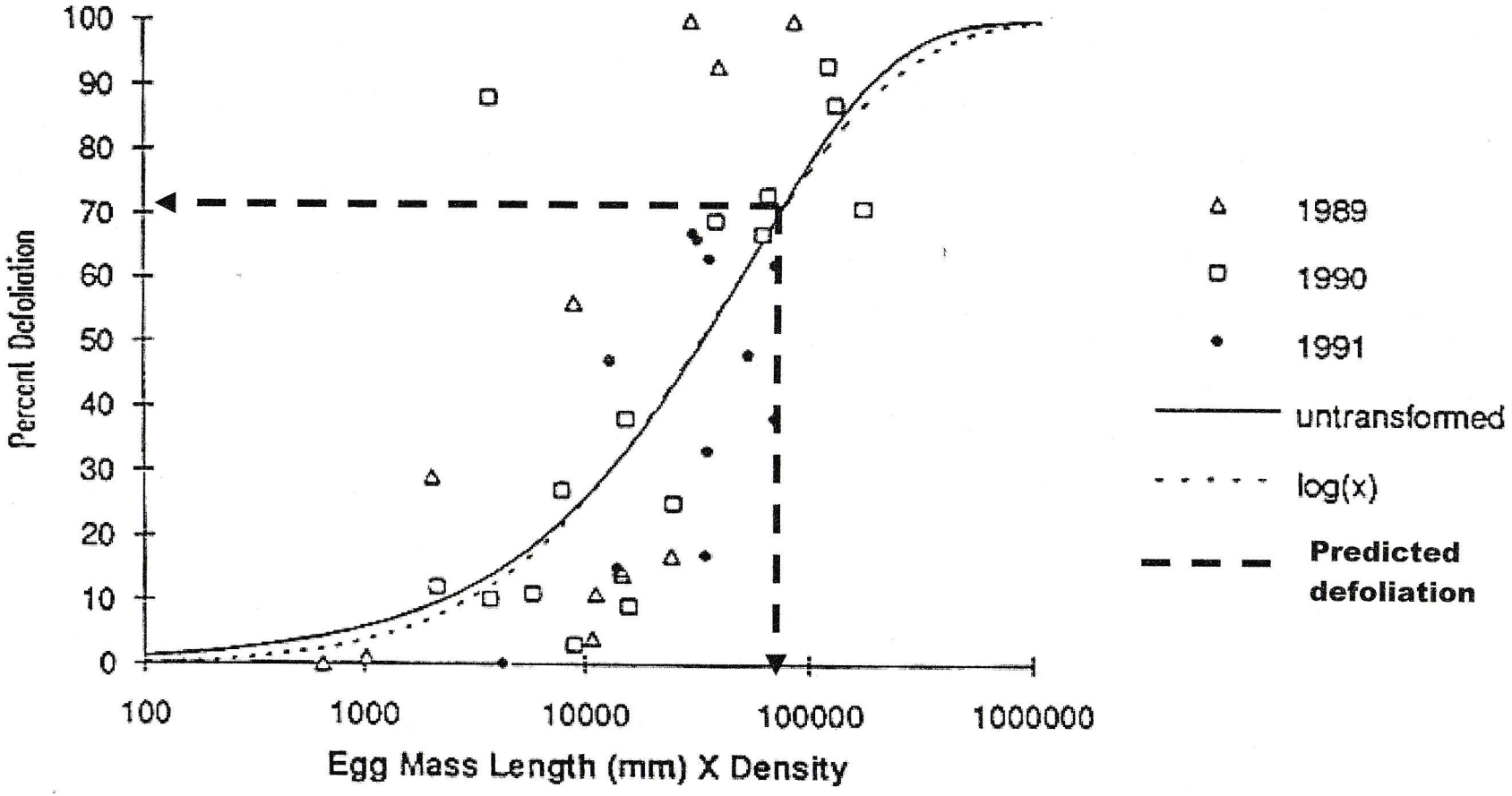
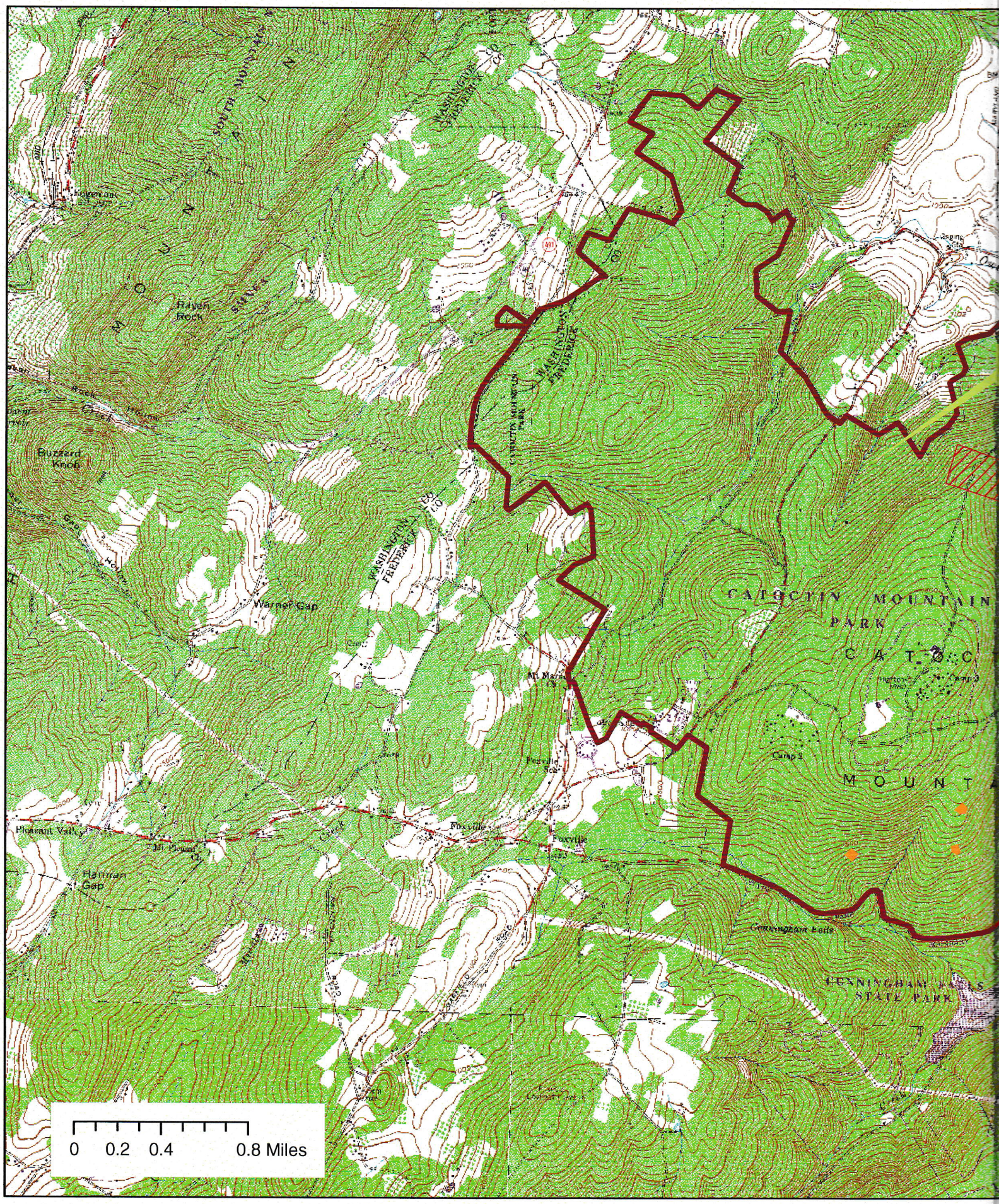

light defoliation expected (30-50%) 1,142 acres
single application of BtK
Heavy defoliation expected > 51%) 2,229 acres
double application of BtK
Little Hazy Mtn
Owens
Fearmont
Wolf Rock
Johnny Reck

Figure 4.—Predicted defoliation in the eastern portion of Catoctin Mountain Park (block 1) in 2008.

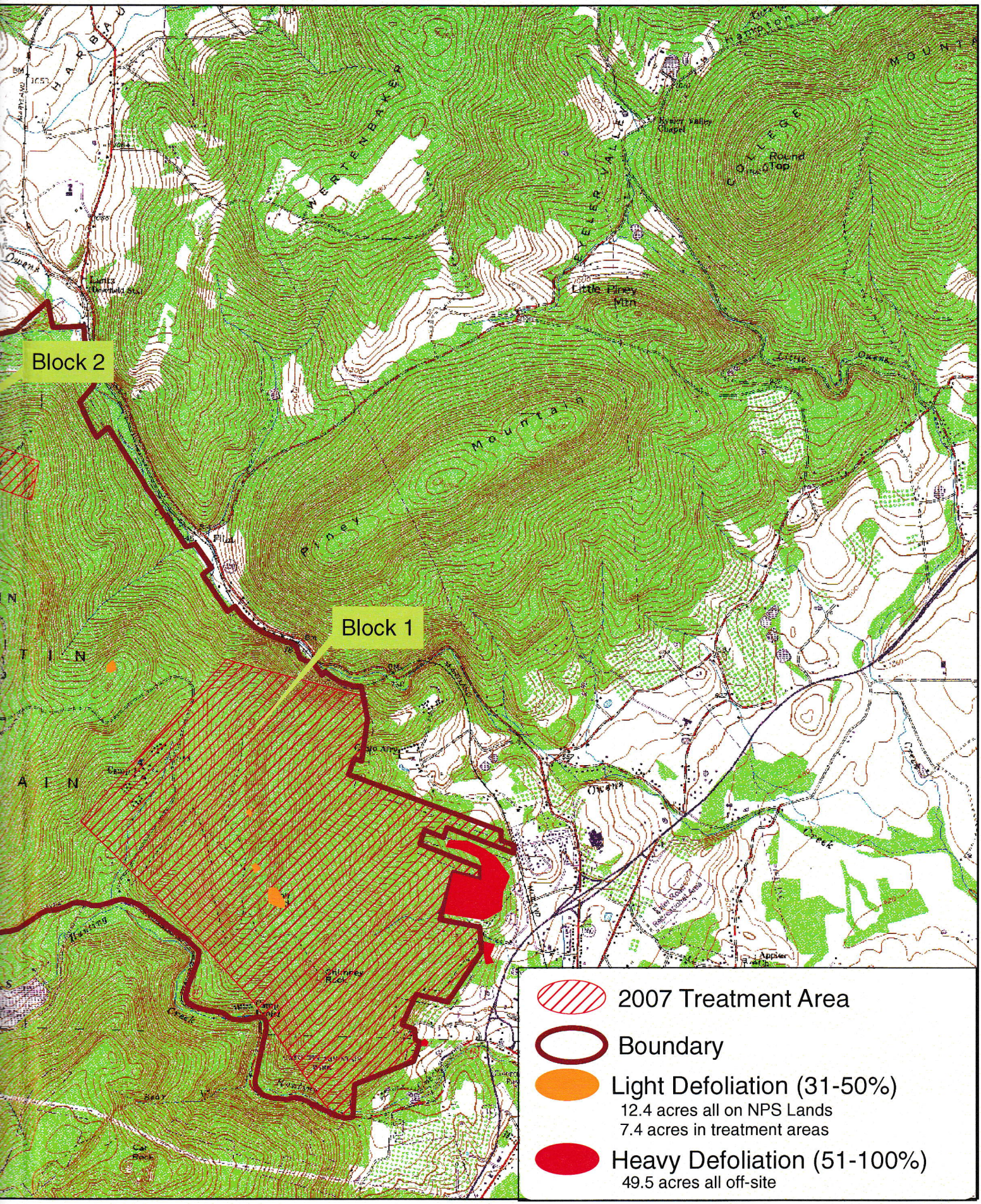


Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

Figure 5. -- Results of the aerial detection survey conducted at Catoctin Mountain Park on June



ıne 11, 2007, along with the 2007 gypsy moth treatment areas.



USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3410
Date: October 15, 2007

Mr. Mel Poole
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mr. Poole:

Enclosed is the gypsy moth biological evaluation for Catoctin Mountain Park.

In brief, gypsy moth populations are sufficient to cause light and heavy defoliation on 3370 acres. We are recommending a single application of *Bacillus thuringienis* variety *kurstaki (Btk)* on 1141 acres and a double application of *Btk* on 2229 acres. With good timing and proper application, gypsy moth defoliation should be minimal at Catoctin Mountain Park in 2008.

I would like to thank your staff for conducting the preliminary egg mass survey.

Please contact me at 304-285-1555 if you have any questions regarding the gypsy moth biological evaluation.

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forester
Forest Health Protection

Enclosure

Cc: Becky Loncosky, CMP
Robert Tichenor, MDA
Thomas Lupp, MDA
Jil Swearingen, CUE
Robert Lueckel, MFO
Noel Schneeberger, Ao

RLW/blm